Book Name: *Part Modeling User's Guide*

Part Information

As you create and modify a part design, you can access information about every feature on the part by choosing the Model Info option from the Info menu. Several Pro/ENGINEER options allow you to add engineering information (such as material or units) to the model database and analyze the model (for example, measuring, interference checks, mass properties, and surface analysis). See Engineering Information in the *Fundamentals* manual for information about the different types of engineering analysis supported by Pro/ENGINEER.

Topic

Part Differences
Surface Curvature Analysis
Curvature Analysis

Part Differences

In Part mode only, the Info menu displays the Part Diff option. This option identifies the variations between the current part and another part, the name of which you specify to the system. Note the following:

- To compare a different version of the same part, you must rename one of the versions because Part Diff does not allow you to select by version number.

- To compare the in-memory version to the latest *saved* version, after you enter the part name, the system prompts you to enter an alternate part name. Pro/ENGINEER retrieves the latest saved version under the new name.

- Enter a [?] to display a namelist menu of parts in the current working directory, or search the directory tree.

Pro/ENGINEER displays the specified part in a subwindow and displays the Diff Info menu. The possible options are as follows:

- **Next**-Compare the next feature in the part.

- **Previous**-Return to the previously compared feature.

- **Feat Info**-The system displays an Information Window with data on the currently highlighted

feature.

As you choose the options Next or Previous from the Diff Info menu, Pro/ENGINEER highlights in sequence the features in the second part that are different from those in the first. The system displays a message indicating that the highlighted feature has either been modified from what it is in the first part, or that it does not exist in the first part. When Pro/ENGINEER has highlighted all the features in the second part that are different, it continues highlighting any features in the first part that differ from those in the second part.

If the two parts have the same features and dimensions, the system displays a message stating that there is no difference between the two parts.

If the two parts are entirely dissimilar, Pro/ENGINEER issues a warning message stating that the two parts do not seem to be related, and asks if you want to continue. Respond with "yes" to continue comparing the two parts feature by feature, or with "no" to terminate the comparison process.

Surface Curvature Analysis

If you have the Pro/SURFACE module, Pro/ENGINEER can perform surface analysis and color rendering of the surface of your part. To access the Surf Info menu to perform surface analysis, choose Info from the Main menu, then choose Srf Analysis from the Info menu.

Note:

> If the configuration file option "shade_surface_feat" is set to *no*, the surface features will not be rendered (displayed).

The Surf Info menu options are as follows:

- **Gauss Curve**-Color the model according to Gaussian curvature.

- **Sect Curv**-Color the model according to sectional curvature.

- **Slope**-Color the model according to the local slope.

- **Porcupine**-Show the section curvature of the surface along isolines.

- **Normals**-Show the surface normal vectors.

- **Deviation**-Calculate the deviation of the curve or points from a surface.

- **Reflect Crvs**-Calculate the reflection curves on a surface or quilt.

- **Hilight Crvs**-Highlight curves that belong to selected quilts or surfaces.

- **Norm/Curvtr**-Calculate the coordinates, and the normal and principal curvatures at a point on a surface.

- **Min Radius**-Calculate the minimum radius of curvature.

- **Dihedral**-Show a graph depicting a dihedral angle along an edge, calculate the dihedral angle at a selected point, or calculate the maximum or minimum dihedral angle for an edge..

- **Draft Check**-Perform a draft check.

- **Offset Mesh**-Preview the mesh offset from a surface or quilt.

Controlling the Color Mapping

For rendering purposes, Pro/ENGINEER assigns colors towards the red end of the spectrum to the maximum curvature or slope. Minimum curvature or slope appear more blue. Values falling within the range appear in varying colors of the spectrum. All points on the surface that have the same value are the same color. You can fine-tune the rendering by specifying what range of values the colors represent.

You can control the color scale used to display shaded images using the configuration option "set_zero_curvature_color". When this option is set to *yes*, Pro/ENGINEER computes the color scale based on the condition that the color green corresponds to the value zero. When the option is set to "no", the system uses the default color scale.

For shaded surfaces, you can control the shading characteristics using options in the Spectrum menu. Pro/ENGINEER automatically displays the Color Range values with the Spectrum menu. The Spectrum options are as follows:

- **Linear**-Use a linear scale for the values mapped to the color spectrum.

- **Logarithmic**-Use a logarithmic scale for the values mapped to the color spectrum.

- **Two Colors**-Display negative values in blue and positive values in magenta.

- **Change Limits**-Change the maximum and minimum limits for the values mapped to the color spectrum. This option is available for both the linear and logarithmic spectrums.

- **Sensitivity**-For a logarithmic scale, modify the accuracy of color mapping. If you increase the sensitivity, the accuracy of shading is improved in the region around the zero value.

- **Step Point**-When the display is in two colors, change the value for color separation.

- **ShadeQuality**-Change the quality of the spectrum by entering a value from 1 to 10.

Gaussian Curvature

When you choose Gauss Curv from the Surf Info menu, Pro/ENGINEER determines the Gaussian curvature as the product of the smallest and largest normal curvatures for every point on the surface. This can produce positive, negative, and zero values (for cylinders and planes).

The following figure illustrates Gaussian curvature.

Gaussian Curvature
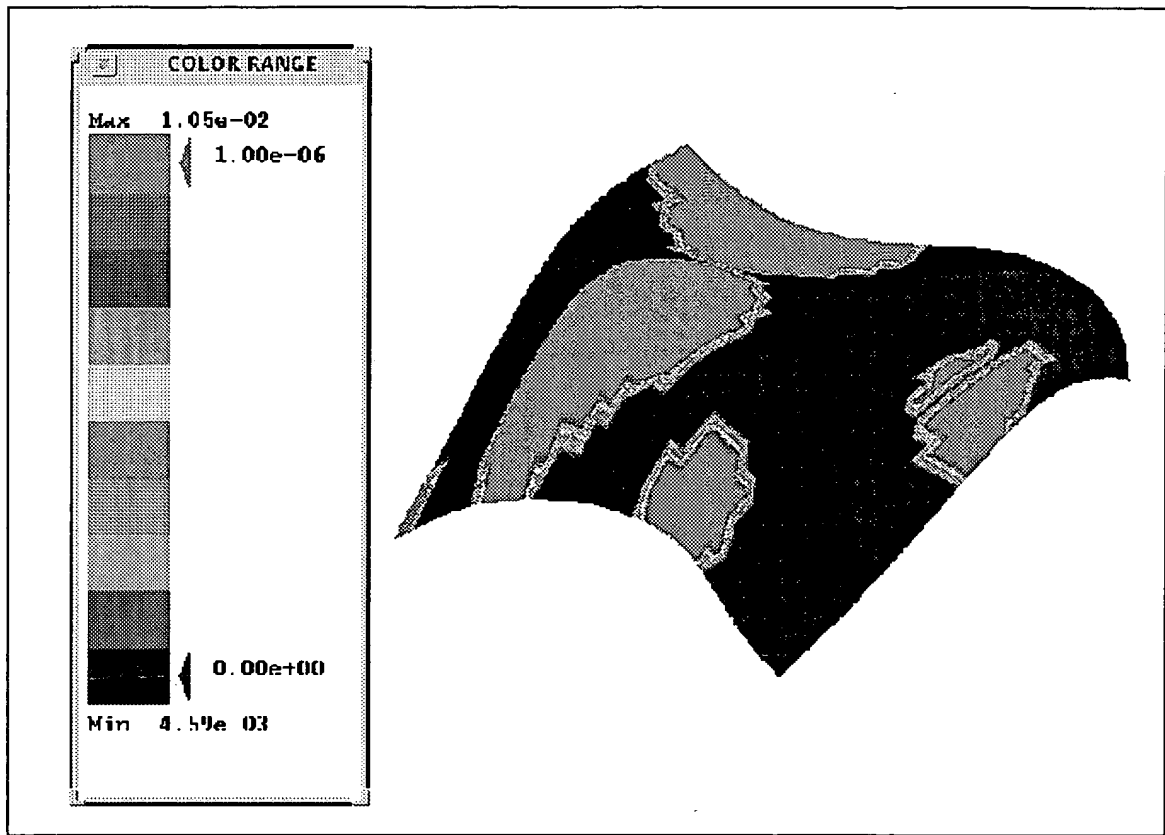
Section Curvature

When you choose Sect Curv from the Surf Info menu, Pro/ENGINEER renders the curvature of cross-section cuts parallel to a reference plane. When prompted, select a datum plane or planar surface. Pro/ENGINEER then sections the surfaces parallel to this reference and calculates the curvature for each section.

The following figure illustrates section curvature.

Section Curvature

Section Curvature with respect to DTM2

Section Curvature with respect to DTM3
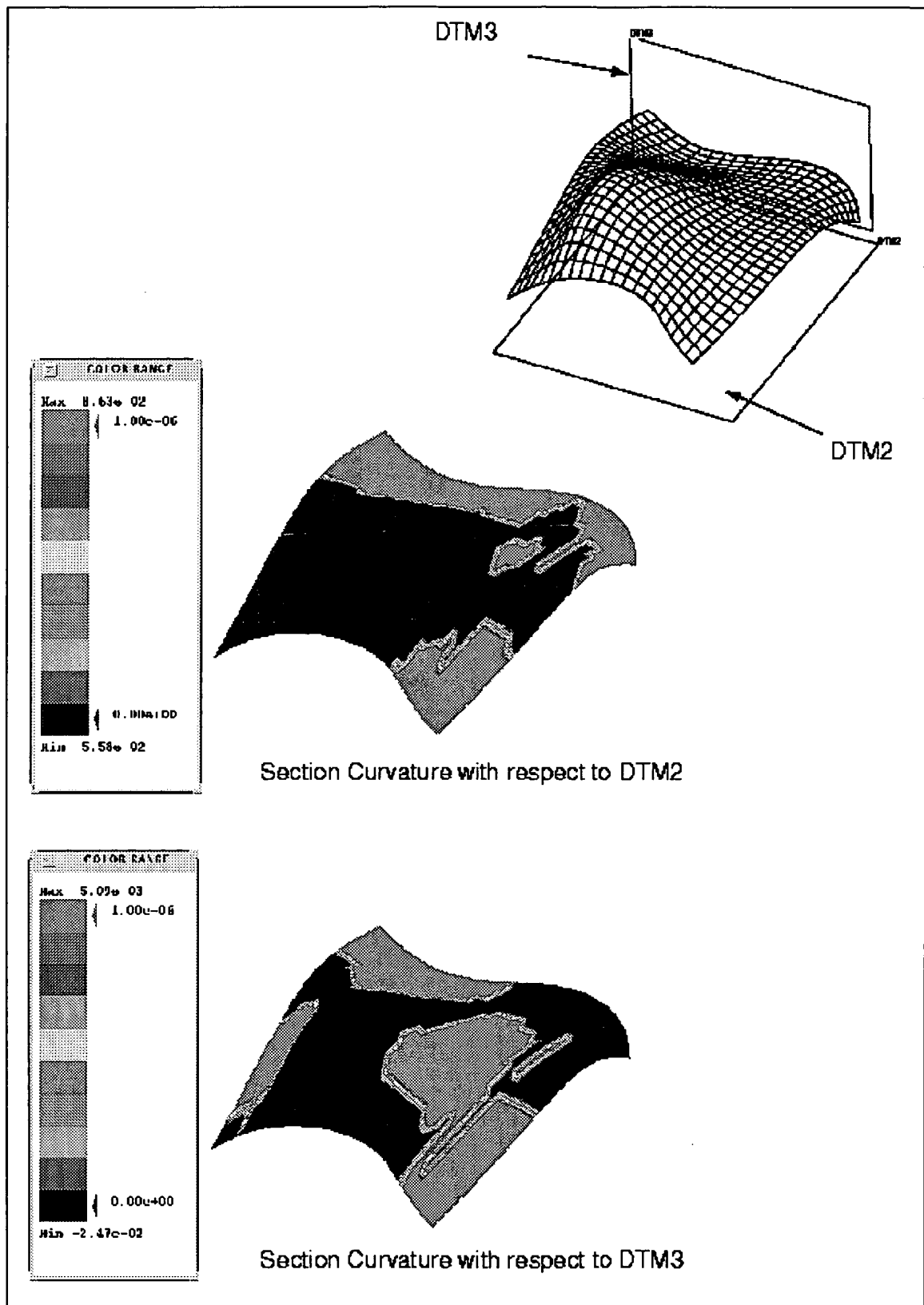
Slope

The Surf Info menu Slope option renders the slope of a surface relative to a reference plane. When prompted, select a datum plane or planar surface, then choose the direction for positive slope.

The default reference plane is the ZY-plane. To select the default reference plane, choose Done Sel in response to the prompt to select a reference plane.

The following figure illustrates the slope of a surface.

Slope of the Surface
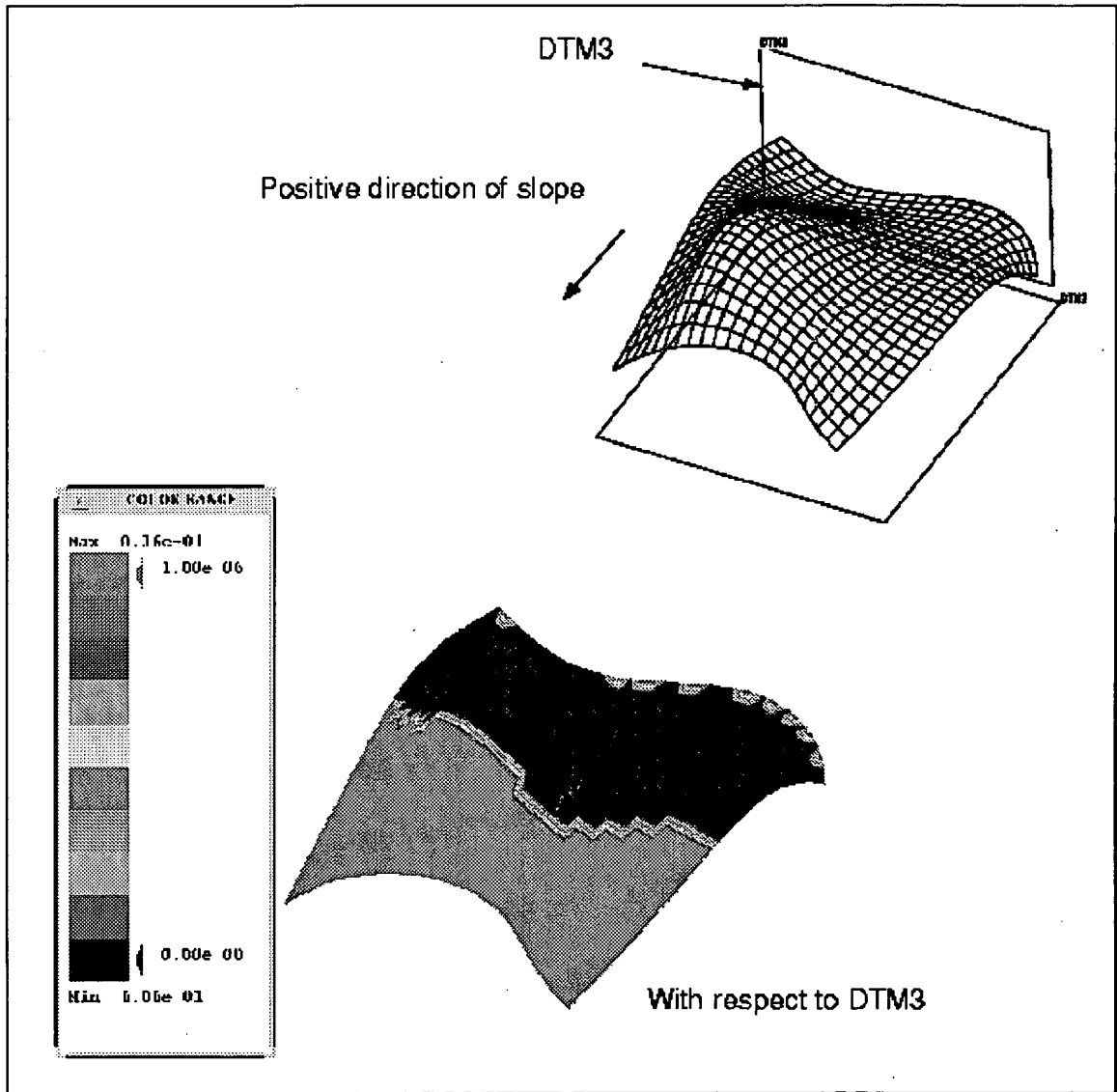
Porcupine

The Porcupine option in the Surf Info menu graphically displays the curvature of a surface, similar to the way the system displays curvature for curves. To display the curvature, Pro/ENGINEER uses isolines and line segments normal to the isolines. Isolines are equally spaced lines that display the contour of the surface in one direction. The system spaces the normal line segments equally along the isolines, and their length is proportional to the curvature of the surface in the direction of the isoline at that point. You can choose either of two directions (or both) for displaying isolines on the surface.

The following figure illustrates the Porcupine option.

Normal Sectional Curvature Using Porcupine
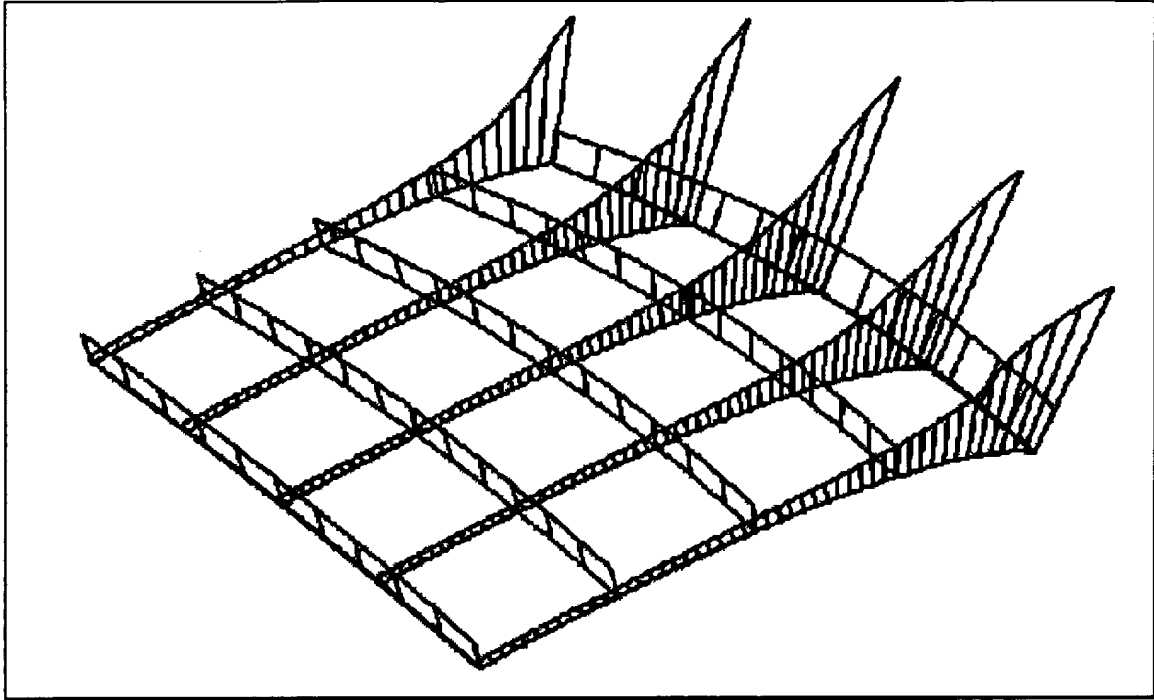
How to display normal sectional curvature for a surface

1. Choose **Srf Analysis** from the INFO menu and **Porcupine** from the SURF INFO menu.

2. Pro/ENGINEER displays the PORCUPINE OP menu, which has the following options:

   - **Select Srf**-Select the surface on which to display the porcupine isolines.

   - **Scale 1st**-Specify the relative scale of the curvature display (that is, of the normal line segments) in the direction of the red arrow.

   - **Scale 2nd**-Specify the relative scale of the curvature display in the direction of the blue arrow.

   - **Density**-Specify the relative density of the curvature display in both directions.

   - **Spacing 1st**-Select a spacing option between the isolines in the direction of the red arrow using the options in the SPACING OPTS menu. The possible options are as follows:

      - **Uniform**-Uniform spacing in this direction.

      - **Customized**-Customize spacing in this direction by picking points on the surface through which porcupine curves will pass. Choose **Done Sel** when you have finished.

      - **Keep Current**-Do not change the current spacing in this direction.

      - **None**-Do not display isolines in this direction (display isolines in the other direction

only).

- ○ **Spacing 2nd**-Select a spacing option between the isolines in the direction of the blue arrow using the SPACING OPTS menu options.

Normals

To display vectors that are normal to a selected surface, choose the **Normals** option from the SURF INFO menu. The normal vectors are displayed in green and point away from the selected surface. Pro/ENGINEER displays the NORMALS menu, which has the following options:

- **Change Grid**-Change the number of vectors displayed in the first and second directions of the surface. Enter a number between 3 and 1000.

- **Scale**-Enter a value to change the length of the displayed vectors. The default scale value is 1.0000.

Surface Deviation

The Deviation option in the SURF INFO menu calculates the deviation measured by a normal from a surface to points of a specified curve or a datum points array.

The SRF DEVIATN menu contains the following options:

- **Scale**-Specify the scale for the visual representation of deviation. The scaling factor applies to all the displays of deviation until you reset it.

- **Tolerance**-Specify a tolerance within which deviation is acceptable.

- **Select Srf**-Specify a surface from which to measure the deviation.

- **Sel Dtm Crv**-Select the datum curve to which the deviation is being measured.

- **Sel Dtm Pnt**-Select the datum point to which the deviation is being measured.

- **SelDtmPntArr**-Select the datum point array to which the deviation is being measured.

How to measure the deviation from a surface

1. Choose **Srf Analysis**, then **Deviation**. Pro/ENGINEER displays the SRF DEVIATN menu and prompts you to specify the value of the deviation tolerance.

2. Specify the deviation tolerance, then select a surface from which to measure the deviation.

3. Pick a curve or a datum points array for which the deviation is to be measured.

4. Pro/ENGINEER does the following:

   - ○ Displays the value of the maximum deviation for the selected curve in the Message Window.

   - ○ Graphically displays the deviation based on the current scaling coefficient. If necessary, you

can zoom in to better view the graphical representation of the deviation.

- ○ Creates a data file for each curve selected. This file contains the coordinates of the points that were used for measuring the deviation and their respective deviation value. The name of the file is *deviation.dat.#*, where # is the version number (if you measure the deviation multiple times).

5. You can pick other curves to measure from the previously selected surface.

Reflection Curves

The Reflect Crvs option in the Surf Infomenu displays reflection curves that represent the reflection from linear sources of light on a surface, when viewed from a particular direction. You can display the following groups of reflecting curves:

- Curves that pass through selected points

- Curves that are within a specified range of visibility

- Curves that are in the entire range of visibility from a viewing direction

The system generates the curve for the entire visible surface that corresponds to the selected option. Any part of the reflection curve that extends beyond the silhouette line (the boundary line of visibility on a surface) would be hidden from view. In certain conditions, this gives the appearance of separate reflection curves being created for a single linear light source. However, these are actually segments of a single reflection curve, part of which is hidden from view beyond the silhouette line.
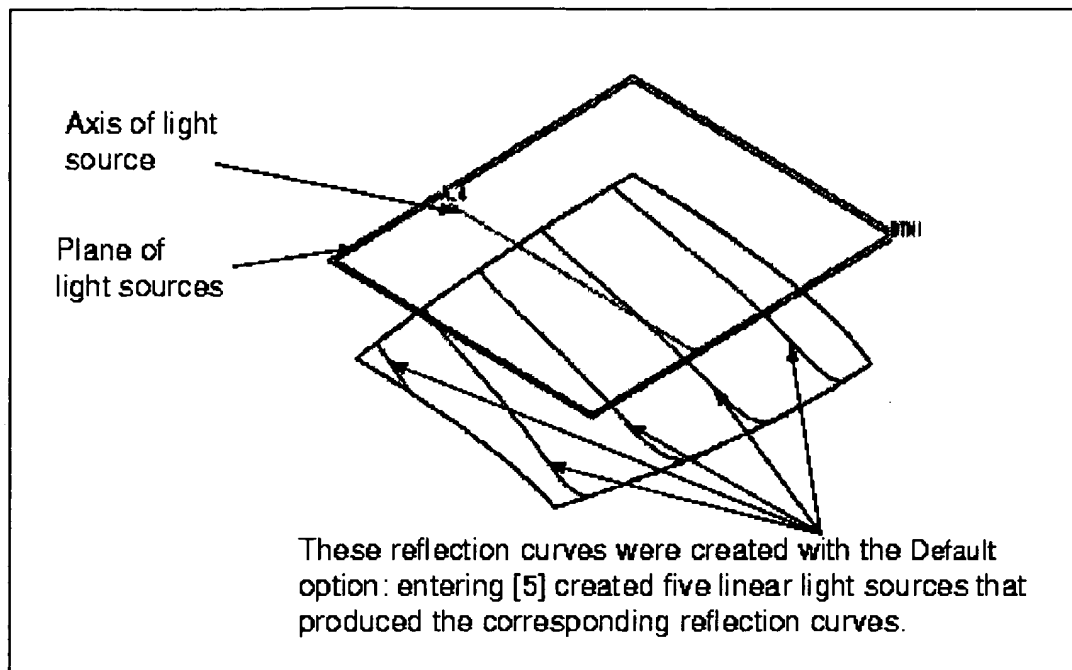
Before displaying reflection curves, you need to set up linear light sources.

How to set up linear light sources

1. Create a datum plane of light sources.

2. Create datum axes that represent linear light sources. These axes must lie in the datum plane of light sources.

The following figure illustrates reflection curves.

Displaying Reflection Curves

Axis of light source

Plane of light sources

These reflection curves were created with the Default option: entering [5] created five linear light sources that produced the corresponding reflection curves.

How to display reflection curves

1. Choose **Reflect Crvs** from the SURF INFO menu. The system displays the REFLECTION menu. Choose **Select**.

2. Pick a reflecting surface or quilt to examine. The system will display reflection curves on this surface or quilt.

3. Pick a plane to determine the viewing direction (normal to this plane), or choose **Done Sel** to use the viewing direction of the current view.

4. Pick an existing datum plane as the plane that contains the light sources.

5. Pick an existing axis as the axis of the light source. The axis represents a strip of fluorescent lighting and must be in the plane of light sources. All light sources in the plane will be parallel to the axis.

6. The system displays the LIGHT_SRC menu, which lists the following options:

   o **Pick On Surf**-Allows you to pick a point on the surface through which the reflection curve from a single linear light source to the selected viewing plane will pass.

   o **Default**-Creates reflection curves that depict the reflection from the light source across the total range of the surface that is visible from the viewing direction. Pro/ENGINEER prompts you to specify the number of light sources, or to accept the default value of 50.

   o **Range**-Creates reflection curves that depict the reflection from the light source as viewed from the viewing direction. You specify the limits between which the light sources will be placed. The start and end of the range must be between the first and last visible light sources identified by using the **Default** option.

   Pro/ENGINEER prompts you for the following information:

- The distance between the light sources

- The number of light sources in the direction of an arrow that is displayed in the Main Window

- The number of light sources in the opposite direction

 Pro/ENGINEER then does the following:

- Generates the light sources, uniformly spaced on the plane of light sources, with one of the light sources coincident with the axis.

- Displays in the Message Window the distance between each light source and the coordinates of the first and last visible light sources.

Surface Normal and Principal Curvatures

You use the Norm/Curvtr option to determine the normal and principal curvature vectors at the specified point on a surface.

A normal to the surface at a selected point is a normal curvature vector. Principal curvature vectors are determined as follows: for every plane that contains the normal vector, there is a curve of intersection of this plane with the surface. Pro/ENGINEER evaluates all the intersection curves to determine the maximum and minimum curvature value. There may be only one curvature value if it is the same for all planes. The curvature values are called the "principal curvatures" of the surface at the specified point. Curvatures can be positive and negative-the sign is negative if the curve turns in the direction away from the normal. The intersection of planes that contain the principal curvatures with the tangent plane defines the principal directions.

Normal and Principal Curvature Vectors
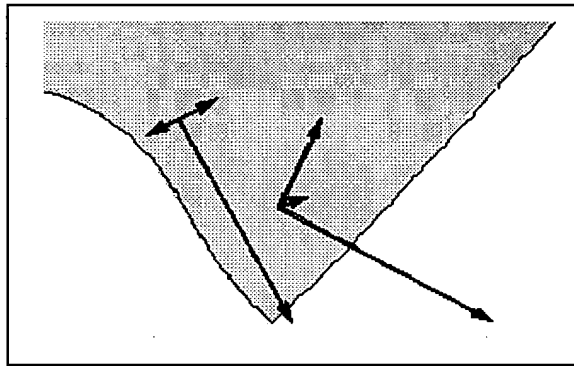
How to display the surface normal and principal curvature information

1. Choose **Norm/Curvtr** from the SURF INFO menu.

2. Select a coordinate system.

3. Select a point on the surface.

4. The system displays an Information Window with the following information:

   o The coordinates, unit normal, and unit direction vectors in the chosen coordinate system

   o The signed principal curvatures at a point on a surface

   o The principal radii of curvature

   o The product of the principal curvatures (the Gaussian curvature)

The following figure illustrates a sample Information Window.

Sample Curvature Information

```
Point:      (         4.63         9.01       -15.9365)
Unit normal:    (     0.24510/      0.477659    -0.043661)

Least (signed) curvature: -0.0051014
Radius of curvature: 11.7507
Direction of least curvature: (      0.133263    -0.070515    -0.150693]

Greatest (signed) curvature: -0.0529309
Radius of curvature: 18.8897
Direction of greatest curvature: (      0.960293   4.13479e-10      0.270992)

Gaussian curvature: 0.0045051/
```

In addition, at the selected point on the surface, the system displays the unit normal vector and two tangent vectors whose values are scaled by the absolute values of the principal curvatures of the surface at the selected point. The vectors point in the directions of the extreme normal curvature and are orthogonal. On planes, spheres, and other surfaces where curvature is the same in all directions, the system chooses the vectors arbitrarily. The vector displayed in green shows normal curvature (the unit normal vector). The color of a principal curvature vector depends on the curvature value and sign, as follows:

- Blue-Most negative curvature

- Cyan-Least negative curvature

- Red-Most positive curvature

- Orange-Least positive curvature

Minimum Radius

Use the Min Radius option to calculate the smallest positive and negative radii for a surface. Pro/ENGINEER displays a point of the minimum positive radius in red and displays a point of the minimum negative radius in yellow, and prints the minimum radii in the Message Window.

This function is useful for deciding the maximum tool radius that can be used for a manufacturing operation.

Dihedral Angle

The system calculates the dihedral angle by measuring the angle between the surface normals at an inner surface edge or at coincident surface edges. The following figure illustrates the maximum dihedral angle.

Calculating the Dihedral Angle
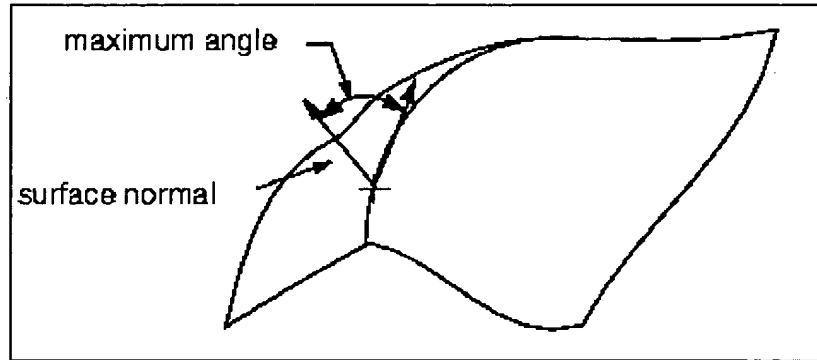
How to obtain information about a dihedral angle

1. Choose **Dihedral** from the SURF INFO menu.

2. Select an option from the DHDRL ANGLE menu:

   o **Along Edge**-Select an edge for which you want to display a graph depicting the dihedral angle. You can set the following parameters by using options in the DHDRL EDGE menu:

      ■ **Select Edge**-Select the edge for measuring the dihedral angle.

      ■ **Scale**-Set the scale of the graph for depicting the dihedral angle along the edge.

      ■ **Density**-Set the density of the graph for depicting the dihedral angle along the edge.

   o **At Point**-Calculate the dihedral angle at the selected point. Pick a point on an edge. The system shows the selected point as a green cross and prints the value of the dihedral angle in the Message Window.

   o **MaxDihedral**-Calculate the maximum dihedral angle for the selected edge. The system highlights the selected edge in blue, shows the point of maximum dihedral angle as a green cross, and prints the value of the maximum dihedral angle in the Message Window.

   o **MinDihedral**-Calculate the minimum dihedral angle for the selected edge. The system highlights the selected edge in blue, shows the point of minimum dihedral angle as a green cross, and prints the value of the minimum dihedral angle in the Message Window.

   o **To File**-Output information to a file.

Draft Check

The Surf Info menu Draft Check option analyzes a part design to indicate if a draft will be necessary and,

if so, any changes to the draft that would be required for the part design to be used in a Pro/CASTING or Pro/MOLDESIGN application.

Draft checking is based on a user-specified draft angle and a hypothetical vector called the "pull direction". The pull direction represents the direction in which a part will be removed from a mold or cast assembly. To determine if the surfaces of a selected part should be modified with the draft, the system compares each of the surface normals of the part to the pull direction.

For additional information, see the *Pro/CASTING User's Guide*.

Offset Mesh

Use the Offset Mesh option in the Surf Info menu to preview the mesh which is offset from a surface or quilt. Selecting Offset Mesh brings up the Offset Msh menu with the following options:

- **Change Mesh**-Enter a factor for changing the mesh density.

- **SelectSrface**-Select a surface to offset from.

- **Select Quilt**-Select a quilt to offset from.

- **Offset Value**-Enter the offset value in the direction indicated by an arrow.

How to preview the offset mesh

1. Choose **Offset Mesh** from the SURF INFO menu.

2. Choose **SelectSrface** or **Select Quilt** and select a surface or quilt, respectively, to offset from.

3. Choose **Done Sel**.

4. Choose **Offset Value** and enter the offset value in the direction of the arrow. The system shows the offset mesh in red.

5. If you want to change the density of the mesh, choose **ChangeMesh** and enter the factor for u and v lines.

Curvature Analysis

You can show curve properties by choosing Crv Analysis from the INFO menu. The Crv Analysis menu lists the following options:

- **CrvtureDisp**-Display the curvature analysis of a curve.

- **RadiusDisp**-Display the radius of curvature along a curve.

- **Deviation**-Display the deviation of a curve from its reference points.

Regardless of which option you choose, the corresponding submenu determines where the system will

write the information:

- **Screen Disp**-Display the output on the screen.

- **To File**-Display the output on the screen and write the output to a file that you can print.

The following sections describe how to analyze curvature, the radius of curvature, and curve deviation.

Analyzing Curvature

The following procedures explain how to analyze various aspects of curvature.

How to analyze the smoothness of a curve or edge

1. Choose **Crv Analysis** from the INFO menu.

2. Choose **CrvtureDisp** from the CRV ANALYSIS menu. The system displays the GET COORDS menu.

3. Choose a coordinate system using the GET COORDS menu.

4. The system displays the CRV DISPLAY menu. Choose **Select Curve** and select a curve or edge. Pro/ENGINEER graphically displays the curvature and writes the curvature data to the file *curv#.dat*, where # is the feature identifier of the curve. The lengths of the segments are proportional to the curvature or to the radius of curvature of the selected curve.

   To avoid a self-intersecting curvature spline, the displayed curvature vectors point in the direction opposite to the vectors in the output file *curv#.dat*. The vectors in the output file end on the centers of curvature of the curve.

5. To change the lengths of the lines, choose **Scale** and enter a new value. Pro/ENGINEER changes the scale for all the curves that have their smoothness displayed.

6. To change the number of lines, choose **Density** and enter a new value. Pro/ENGINEER changes the density for all the curves that have their smoothness displayed.

The following figure illustrates the graphical display of smoothness.

Graphical Display of Smoothness
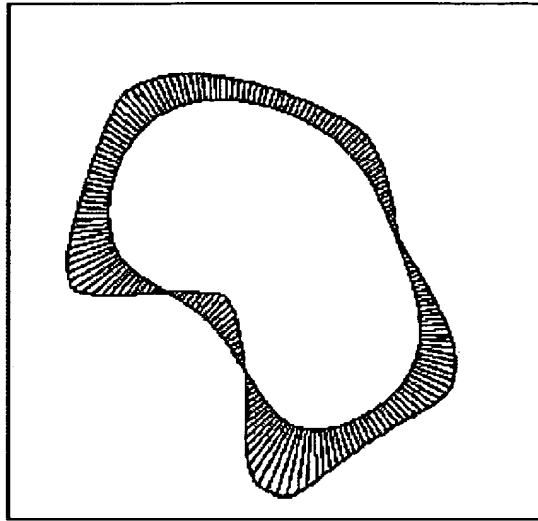
How to analyze the radius of curvature

1. Choose **Crv Analysis** from the INFO menu.

2. Choose **RadiusDisp** from the CRV ANALYSIS menu.

3. Create or select a coordinate system to reference. The system displays the CRV DISPLAY menu. Choose **Select Curve**.

4. Select a curve or edge to analyze. The system displays a curvature scale on the specified curve.

5. To modify the displayed curvature scale, choose **Scale** from the CRV DISPLAY menu to set a value for the curvature scale parameter. Increasing this value increases the relative size of the scale displayed.

6. After modifying the curvature scale values, you can choose **Select Curve** to analyze another curve or edge, another option, or **Done/Return** from the CRV ANALYSIS menu.

How to analyze the deviation of a curve from its reference points

1. Choose **Crv Analysis** from the INFO menu.

2. Choose **Deviation** from the CRV ANALYSIS menu.

3. Enter a tolerance value. The system displays the distances within the tolerance in blue and those outside the tolerance in red.

4. Select a curve to analyze. The system displays a deviation scale on the selected curve.

5. Choose **SelDtmPntArr** and select a datum point array to display the deviation between the curve and the points of the datum point array that you have created.

   ...or...

   Choose **Sel Dtm Pnts** and select one or more datum points to display the deviation between the

curve and the datum points that you have created.

6. You can modify the displayed deviation display parameters by choosing one of the CRV DEVIATN options:

   o **Scale**-Set a value for the deviation scale parameter. Increasing this value increases the length of the normal segments that are displayed.

   o **Tolerance**-Set a value for the deviation tolerance parameter. This value defines the acceptable deviation of a curve from its reference points.

   o **Select Curve**-Select a new curve for which to display the deviation.

7. After modifying the deviation scale values, you can choose **Select Curve** to analyze another curve.

8. Choose **Done** after the deviation analysis is complete.